

SPECTROSCOPY OF LIGHT LEAD AND ACTINIDE NUCLEI USING AN EVAPORATION RESIDUE DETECTOR*

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The spectroscopy of light lead and actinide nuclei produced in fusion evaporation reactions is hampered by the presence of a large fission background. In particular the in-beam spectroscopy of these species requires a “filter” or “tag” to separate the γ rays of the evaporation residues from those of the fission products and other sources of background. There are several solutions to this problem, among them the direct detection of the evaporation residues by time-of-flight and pulse height with a dedicated detection system.

The Washington University group has built a detection system for evaporation residues consisting of 64 fast plastic scintillator detectors arranged in four angular rings. Its main characteristics are a large solid angle coverage ($3.2^\circ \leq \theta \leq 19.1^\circ$ at e.g. 31 cm distance between detectors and target), a high granularity (see above), and a fast timing (10 ns recovery time after a detector hit). The detection system is called HERCULES, an acronym that stands for “High Efficiency Residue Counter Under Lots of Elastic Scattering”, and it is optimized for experiments in conjunction with Gammasphere.

For the commissioning run of the Gammasphere plus HERCULES combination, the $^{48}\text{Ti} + ^{142}\text{Nd}$ reaction at $E_{\text{lab}} = 230$ and 238 MeV and with 2 pA beam intensity has been used (and an angle coverage $\theta \geq 5.6^\circ$ was chosen). In this experiment, new spectroscopic information on yrast and near-yrast states in the very neutron deficient nuclei ^{186}Pb and ^{186}Tl has been obtained which were populated in the 4n and 3pn fusion-evaporation exit channels, respectively [1].

The presentation will cover (i) a description of the HERCULES detection system and its performance, (ii) a brief review of the physics results from the commissioning run, and (iii) a discussion of the perspectives for spectroscopic studies with HERCULES in the actinide region using heavy-ion beams of titanium to neon and embarking on xn as well as on α xn reaction channels (see also ref. [2]). The discussion (iii) will be based on measured residue angular distributions and relative efficiencies from the commissioning run and perhaps also on first results from an upcoming experiment in the region around ^{220}Th with the Gammasphere plus HERCULES combination [3].

*Work supported by US DOE (Grant No. DE-FG02-88ER-40406).

- [1] W. Reviol *et al.*, Phys. Rev. C **68**, 054317 (2003).
- [2] J. F. Smith *et al.*, Phys. Rev. Lett. **75**, 1050 (1995).
- [3] Experiment approved by the ATLAS-PAC at Argonne.